



HINS Beam Success

All Experimenter's Meeting
February 1, 2010

Bob Webber

HINS Program Overview



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- The High Intensity Neutrino Source (HINS) R&D Program has been an active effort since 2005 to demonstrate innovative application of technologies in a low-energy, high-intensity proton/H⁻ linear accelerator for a Proton Driver
 - The HINS linac is being assembled in the Meson Detector Building
 - HINS budget has been ~7-8M\$ (direct costs) per year including M&S and Labor
 - HINS effort has occupied ~40 FTE per year spread across AD, APC, and TD
 - HINS technology is a good candidate for the front-end of a pulsed Project X Linac, less so for a CW Linac
 - The HINS program will lose its independent identity in FY11 as funding for continued activity transfers to Project X and SCRF

HINS Program Traditional Goals

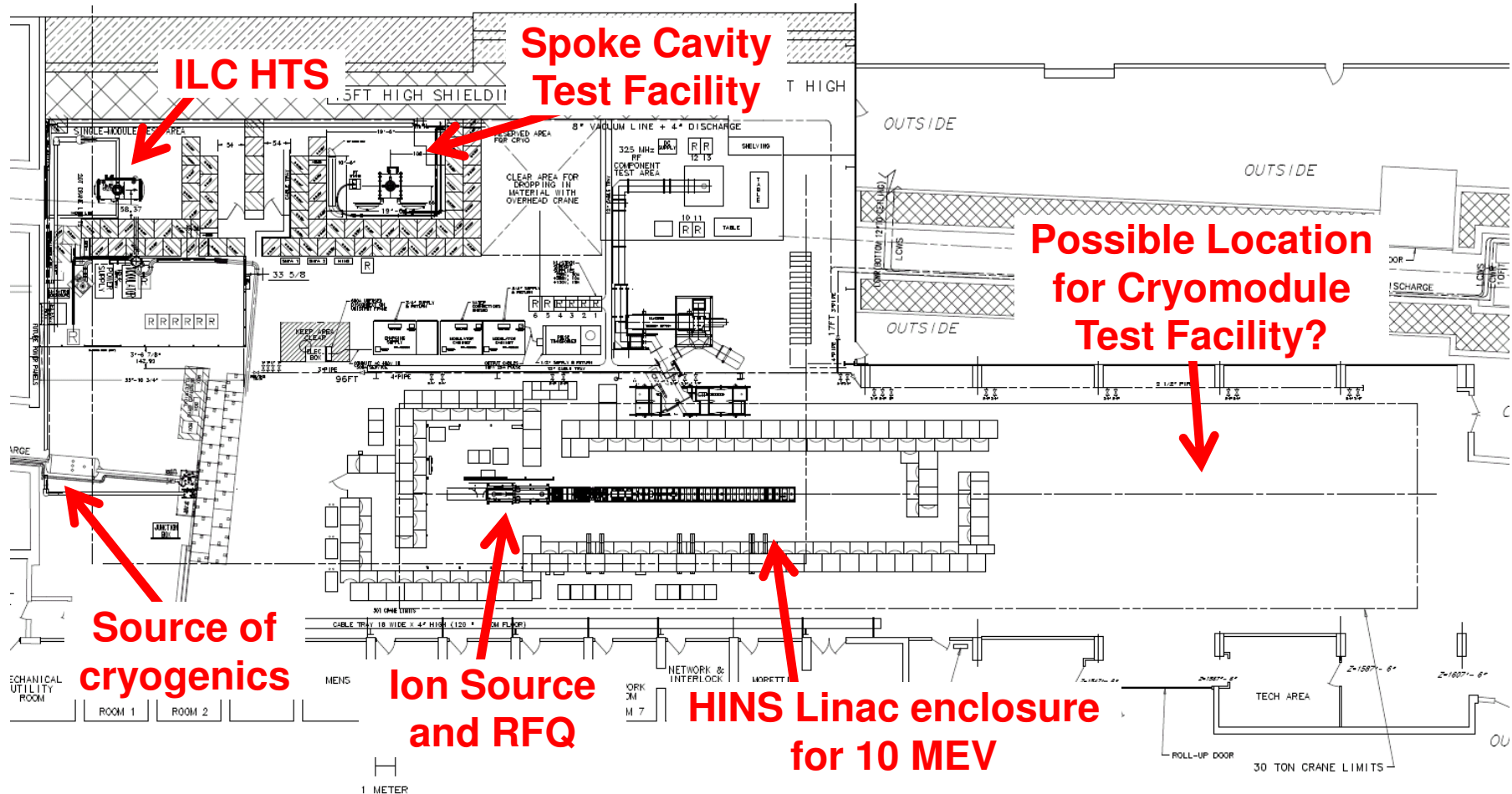


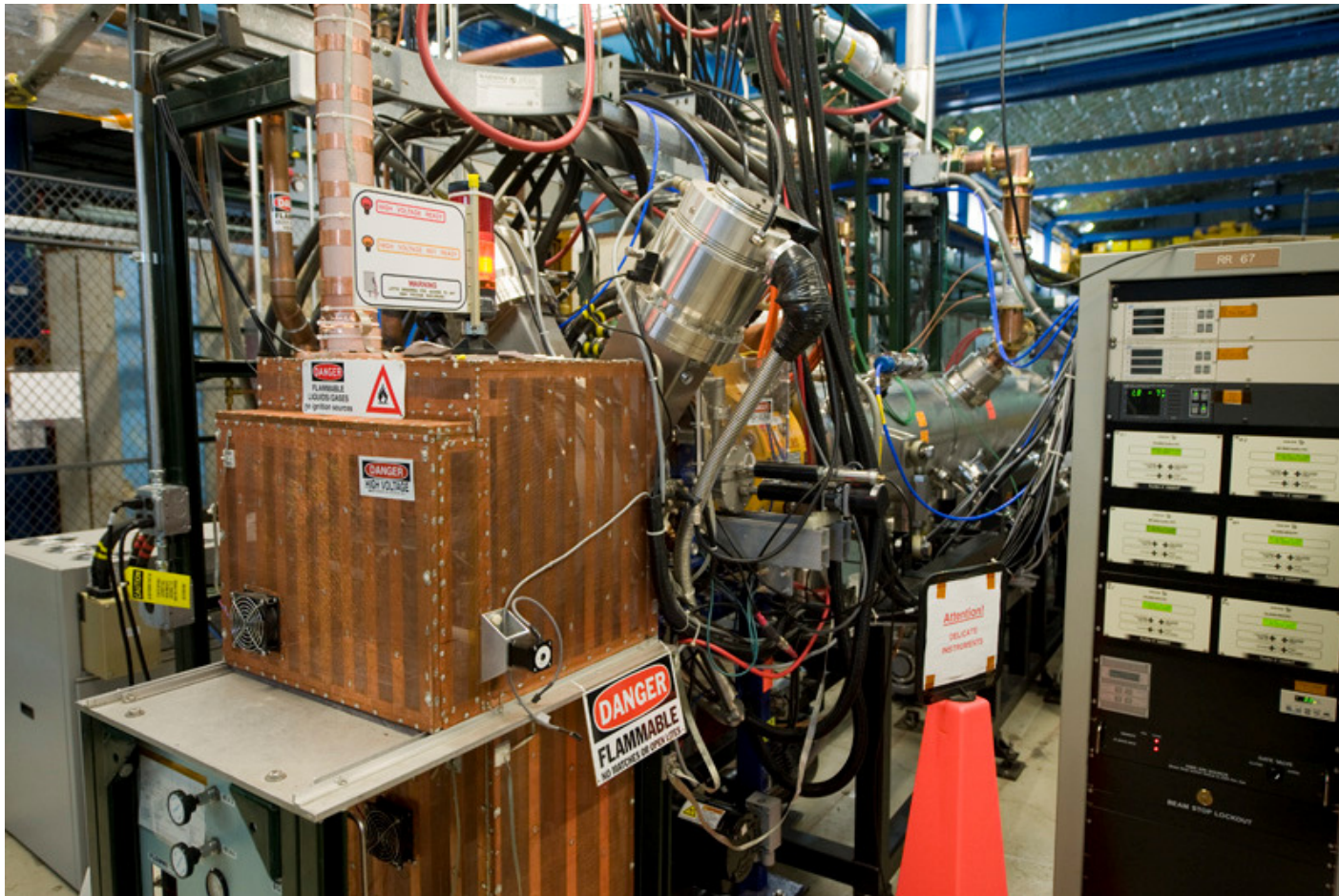
- Mission - To address accelerator physics and technology questions for a new concept, low-energy, high intensity, long-pulse H-superconducting Linac; in particular, to demonstrate:
 - beam acceleration using **superconducting spoke-type cavity structures*** starting at a beam energy of 10 MeV
 - acceleration of a non-relativistic beam through multiple RF cavities controlled with individual high power RF vector modulators driven by a single high power klystron
 - **control of beam halo and emittance growth*** by the use of solenoid focusing optics
 - a **fast, 325 MHz bunch-by-bunch, beam chopper***
- The mission is now being re-evaluated in light of current Project X thinking

* Aspects remaining highly relevant to Project X

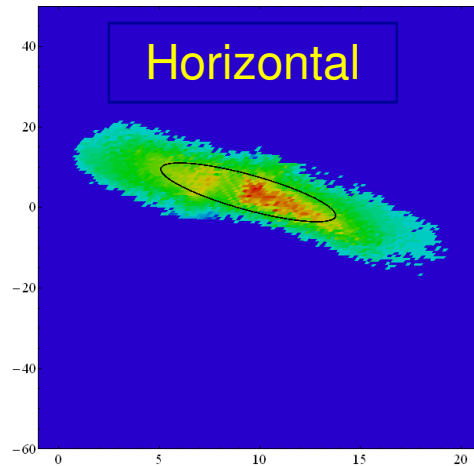


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- The traditional scope of HINS in the Meson Detector Building, comprises:
 - 50 keV ion source
 - 2.5 MeV RFQ
 - MEBT with fast beam chopper system
 - A “room temperature” linac to 10 MeV composed of copper CH-type spoke accelerating cavities and superconducting (SC) solenoid magnets
 - One or two 9-cavity cryomodules of 325 MHz superconducting spoke resonator and superconducting solenoid magnets
 - Pulsed 2.5 MW klystron(s) for RF power
 - Beam diagnostics
 - Scope is currently being re-evaluated in light of current Project X thinking



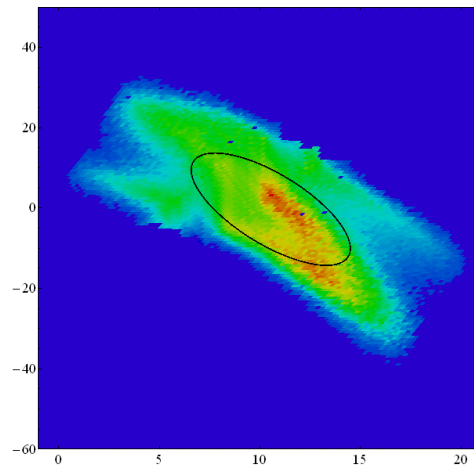
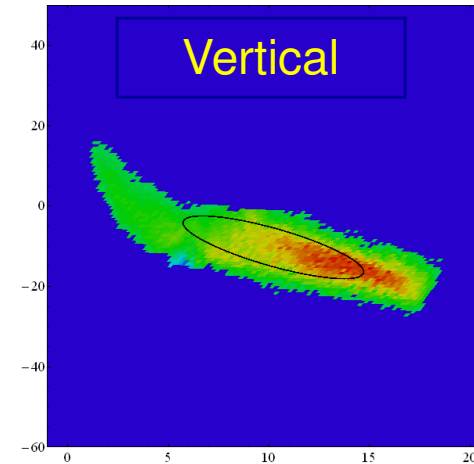


Project X Ion Source Emittance Scan Data

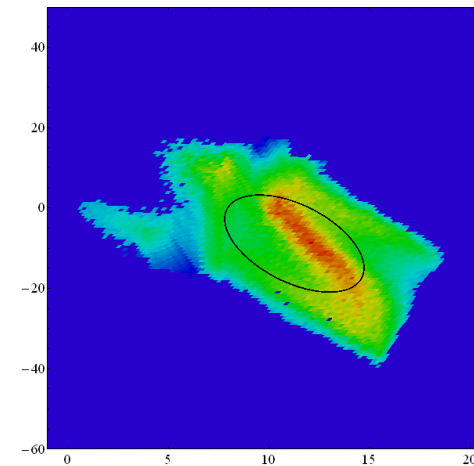


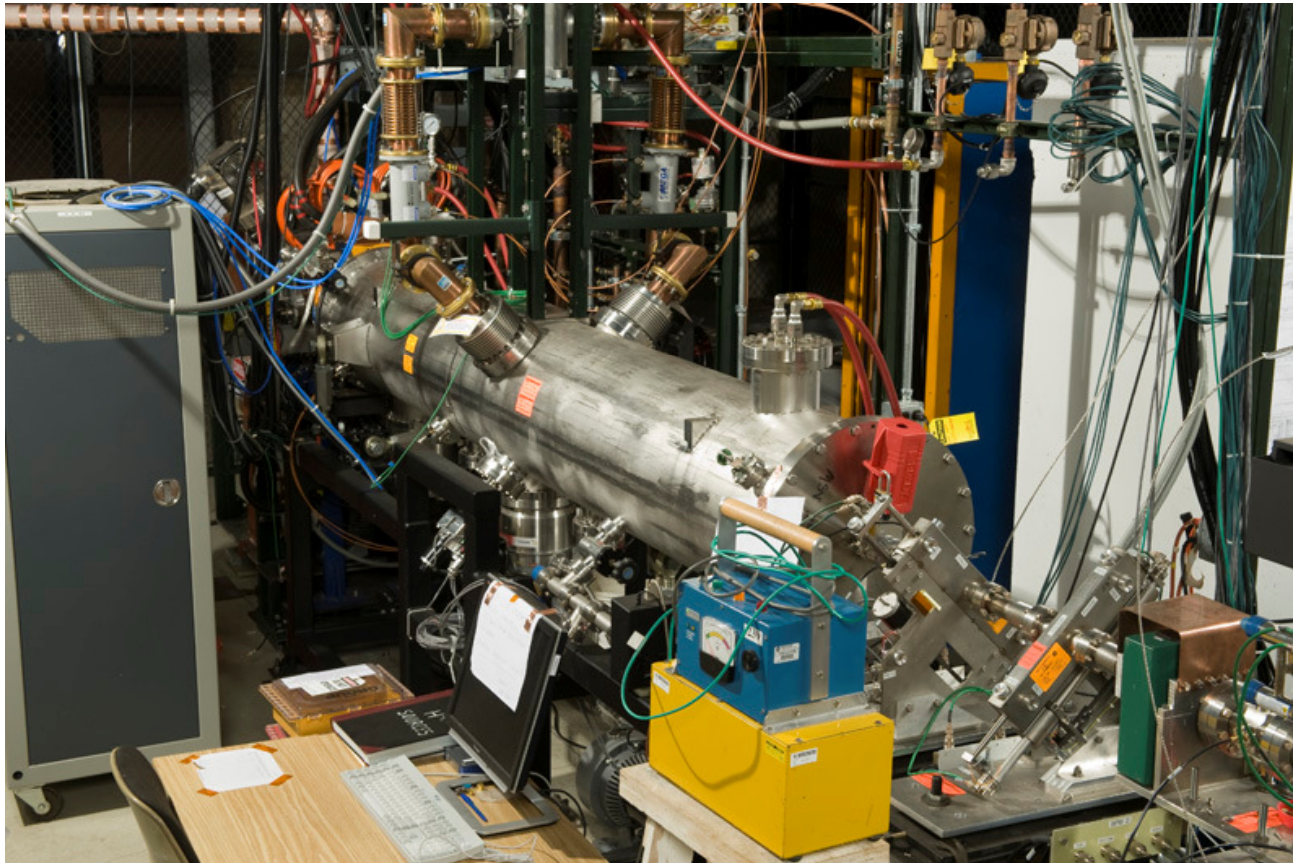
50 keV beam from
HINS proton ion
source

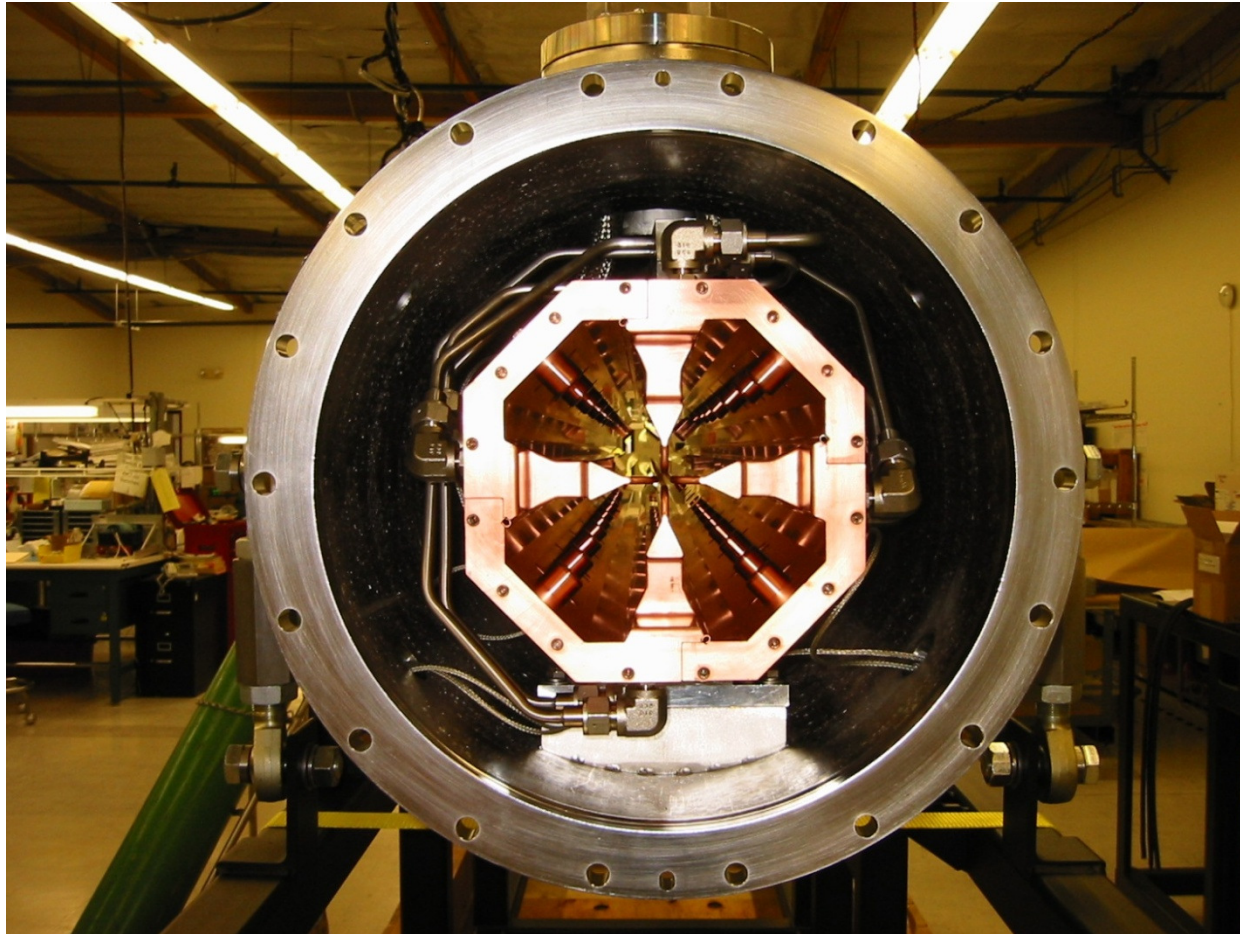
$$I_b = 4 \text{ mA}$$



$$I_b = 12 \text{ mA}$$



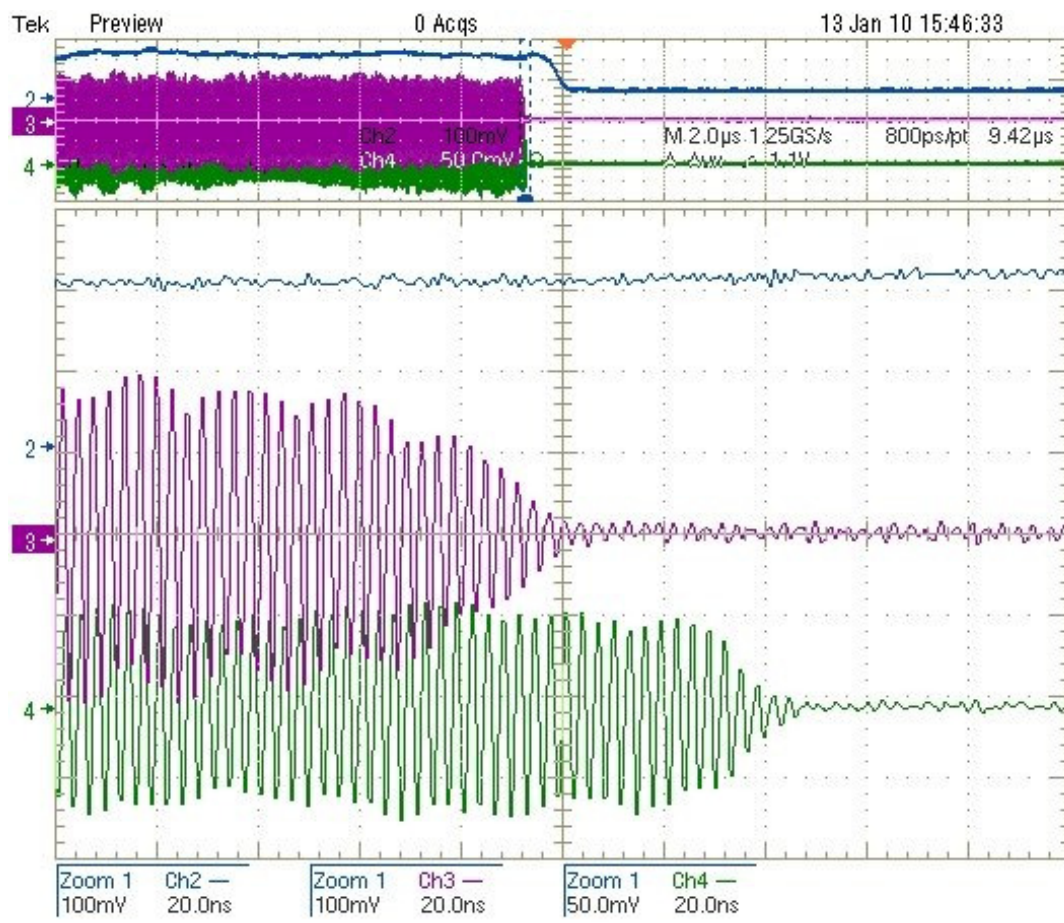






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- RFQ ordered Spring 2006
 - 325 MHz klystron RF power source was installed and commissioned in Meson April 2007
 - RFQ first delivered July 2008
 - Returned to vendor for plumbing correction
 - Received for second time September 2008
 - First RF power applied late December 2008
 - Serious de-tuning problem observed February 2009
 - Returned to vendor for repairs July 2009
 - Received for third time September 2009
 - Powered again and then mated to ion source Nov/Dec 2009
 - First 2.5 MeV beam from RFQ on January 13, 2010
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Project X First 2.5 MeV Beam through RFQ on January 13



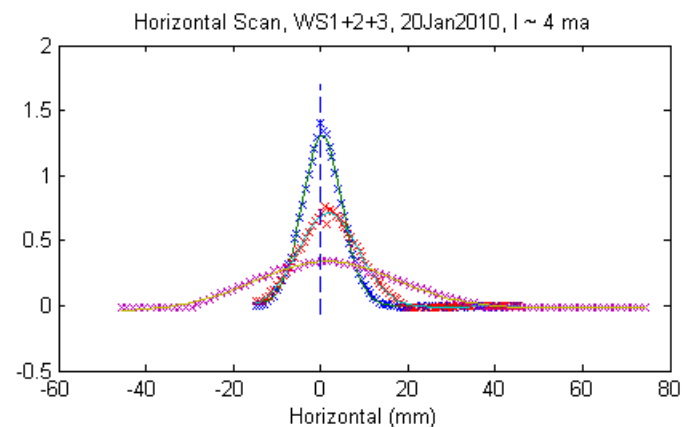
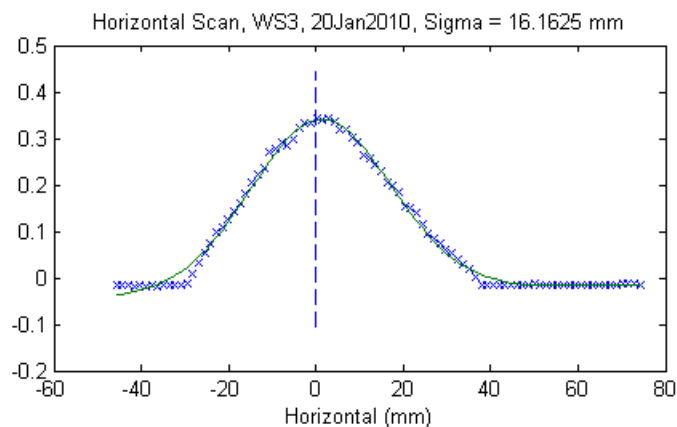
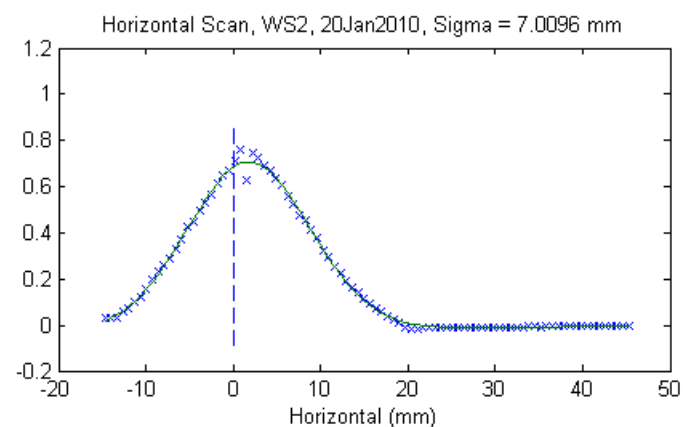
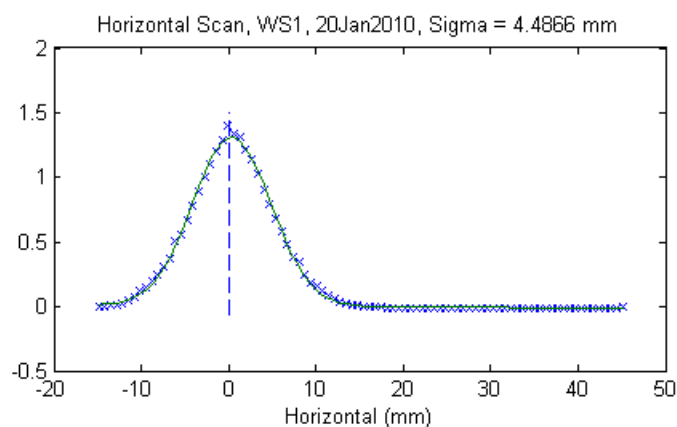
Signals from toroid and two BPM buttons, all downstream of the RFQ

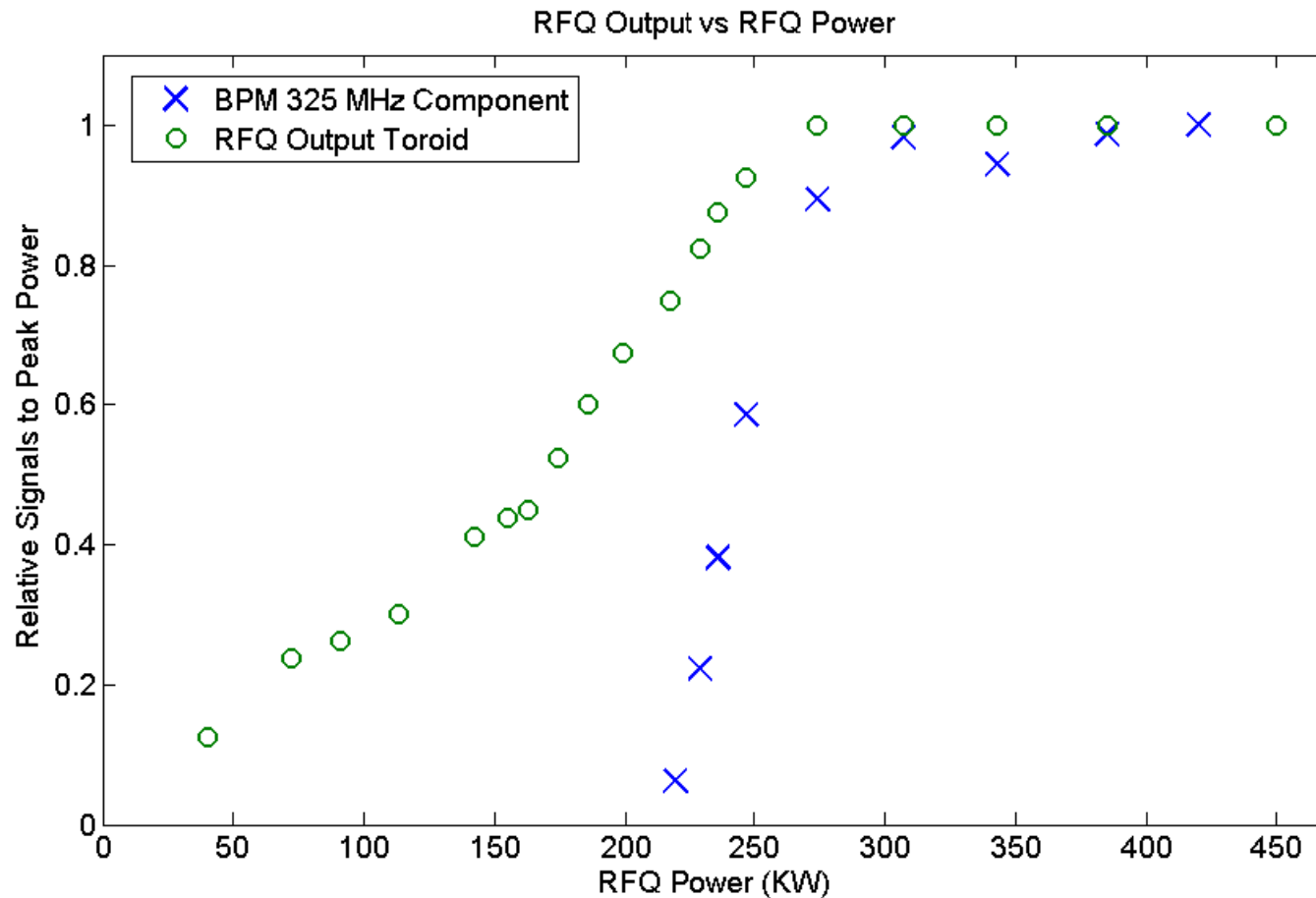
Upper display: 2 μ sec/div
Lower display: 20 nsec/div

Lower display shows the 44nsec delay expected for transit of 2.5 MeV beam between the BPM two buttons separated by 0.96 meters

Beam current is about 3 mA

Typical HINS 2.5 MeV Beam Profiles – Horizontal at 4 mA



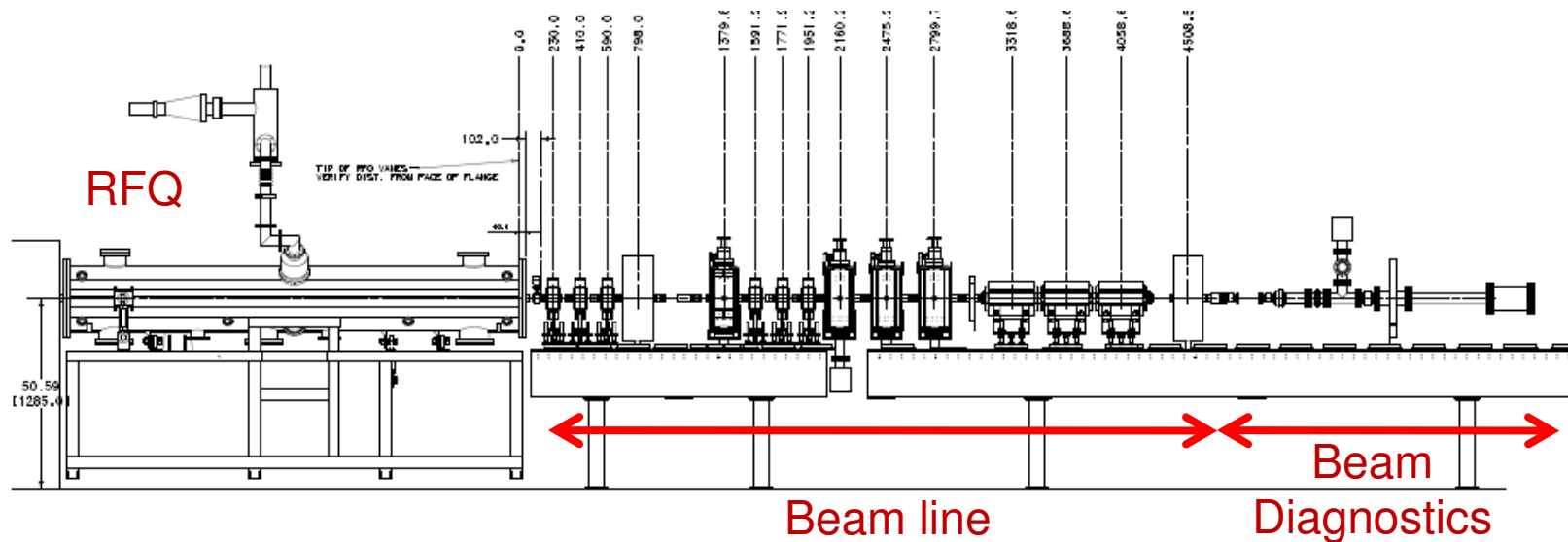




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- Run 2.5 MeV beam from RFQ until ~mid-February
 - Remove RFQ from beam line to replace water tubing seals
 - Complete Linac Cave construction for Six-Cavity Test and 10 MeV operations
 - Future beam operations –
 - Better characterize ion source beam while RFQ is being repaired
 - Re-install RFQ at suitable stage of enclosure construction; not before May 2010
 - Configure 2.5 MeV beam line for transverse beam emittance measurements
 - Install “Six-Cavity Test” RF distribution system and beam line elements; ready for “Six-Cavity Test” ~November 2010
 - Complete HINS Safety Assessment Document, shielding assessment, and safety interlock system modifications for Linac enclosure and Cavity Test Facility Cave
 - In parallel with beam operations, complete 325 MHz Superconducting Spoke RF Cavity Test Facility
 - Fabricate and install cryogenic transfer line tubes to cryostat
 - Install first jacketed SSR1 cavity for CW testing in ~May 2010



- Purpose: early demonstration of beam acceleration with vector modulator control (before availability of cryogenics distribution system)
- Warm quadrupole magnets substituting for SC solenoids
- ~3.0 MeV protons
- Diagnostic line for beam evaluation



Linac Enclosure Under Construction Around Room Temp Section Girder





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- Construct H⁻ linac to at least 10 MeV in pursuit of original HINS goals that remain relevant to Project X
 - Maintain a beam facility for Project X chopper testing and beam instrumentation development
 - Continue SSR1 spoke cavity and cryomodule development activities with design considerations taken for CW and 2° K operation in direct support of Project X
 - Achieve world-first beam acceleration through at least one SSR1 cryomodule



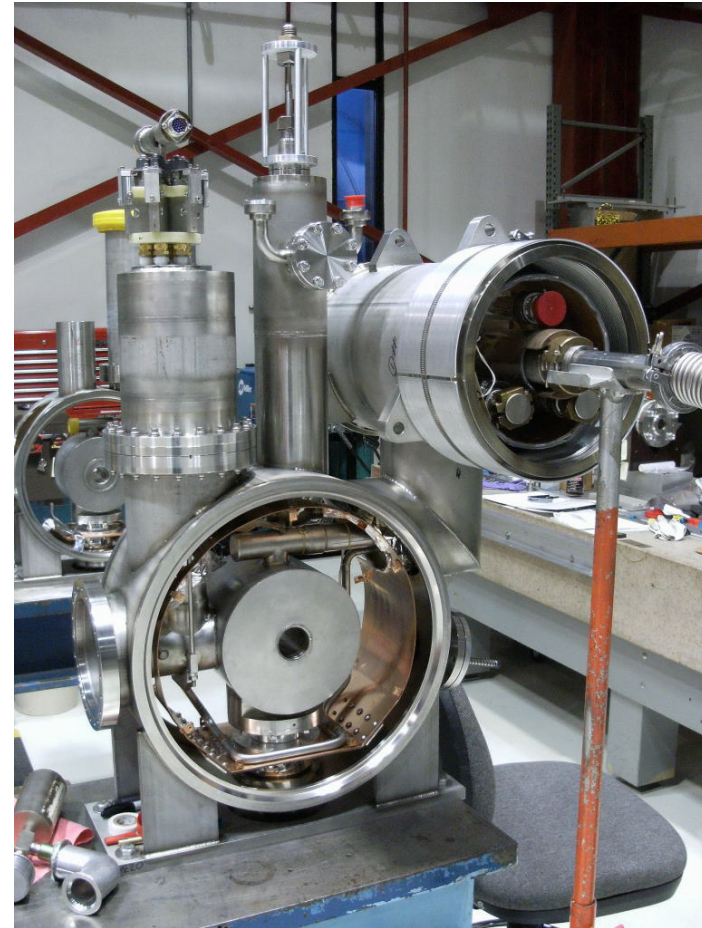
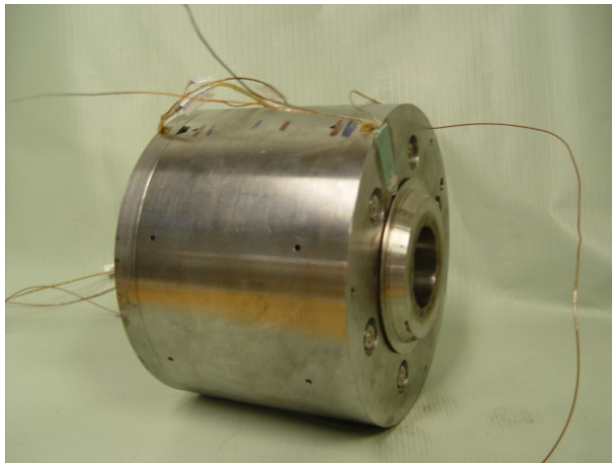
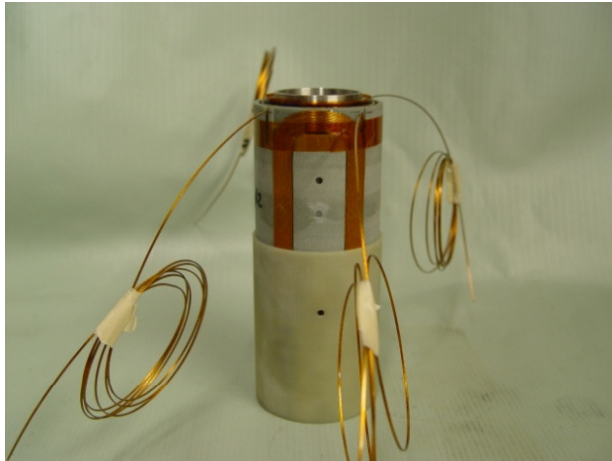
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- The HINS program successfully achieved 2.5 MeV beam from its RFQ on January 13, 2010
 - HINS will provide facilities important for Project X developments:
 - the possibility of 2.5 MeV beam in a shielded enclosure
 - multi-MeV energy beam, via the “Six-Cavity Test”, by spring 2011
 - a facility for RF testing 325 MHz superconducting spoke cavities by late spring this year
 - HINS will fold into the Project X and SCRF programs next fiscal year, losing its independent identity



Project X Tested RT-CH and Buncher Cavities



Room Temp Section Solenoid & Cryostat



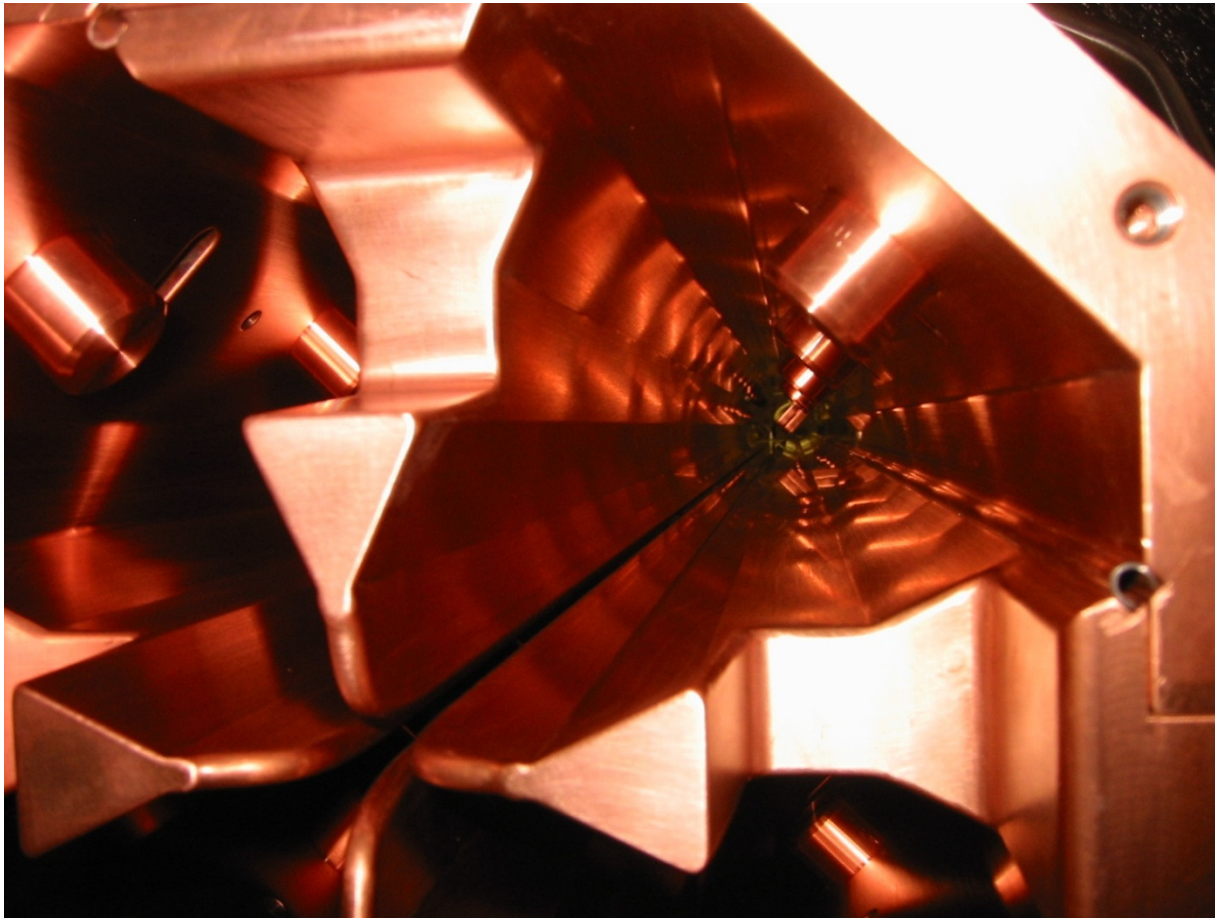
SSR1 Cavity – Bare and with Helium Vessel and Tuner



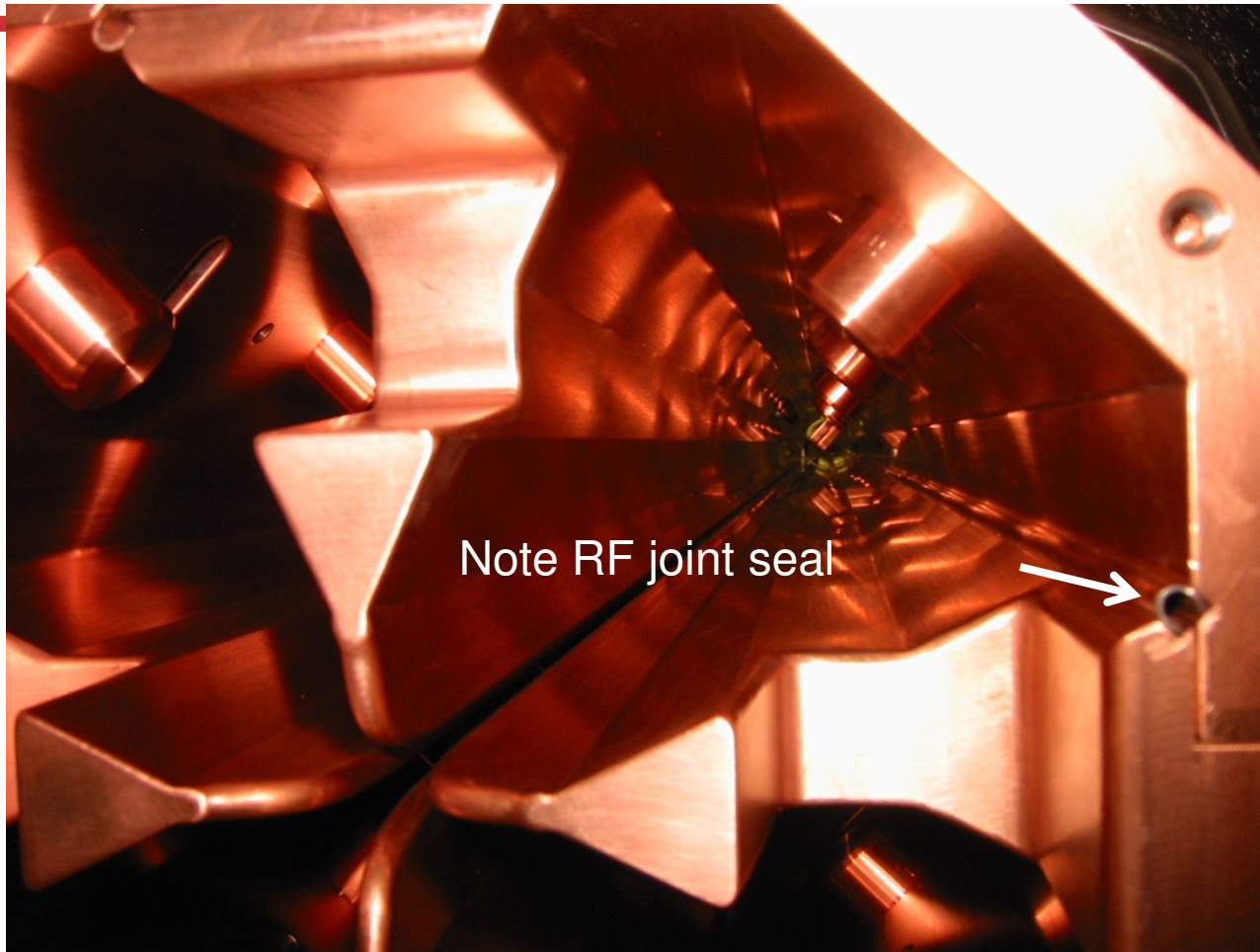


In MDB awaiting
installation into
test cavity cave

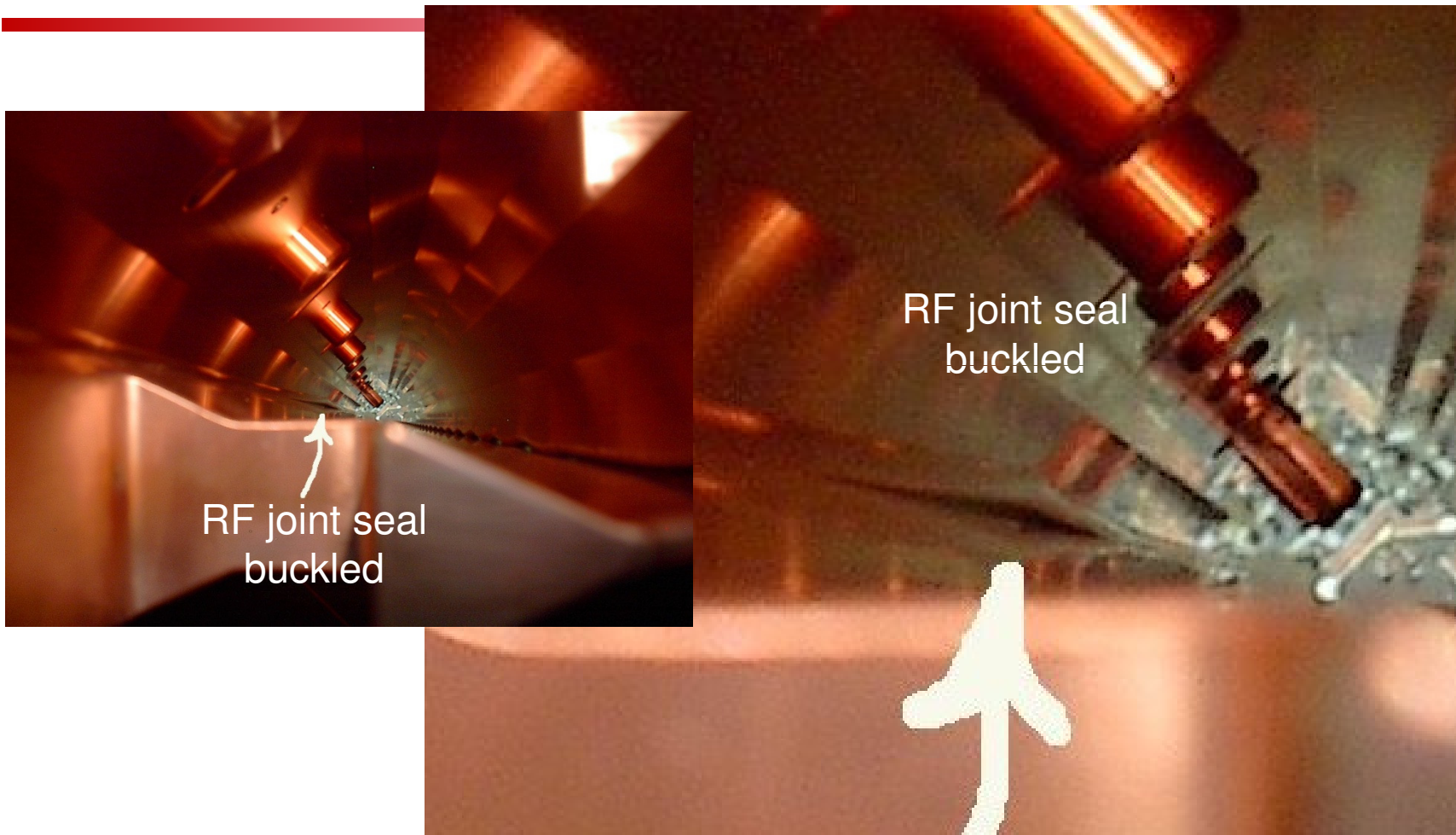


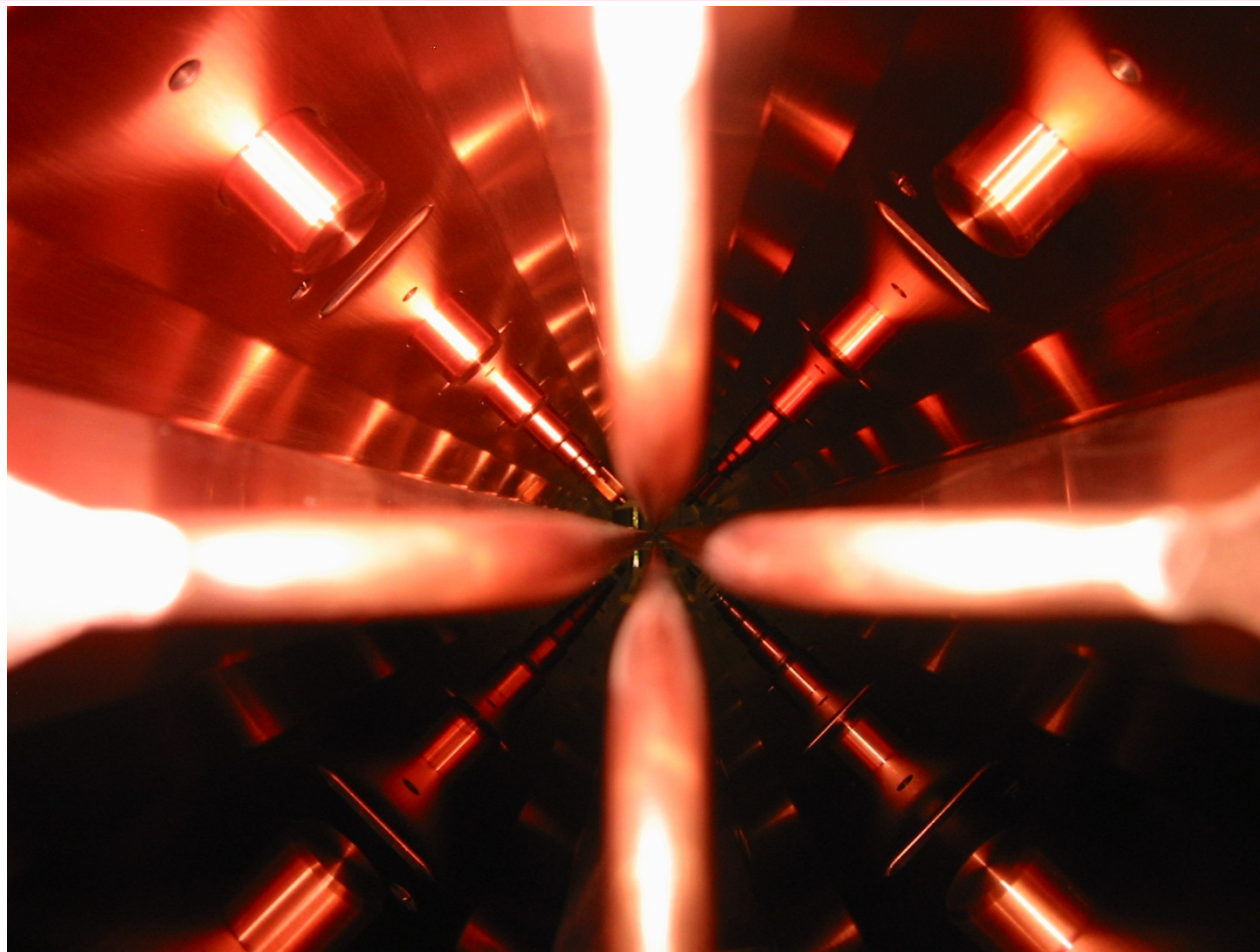


RFQ Close-up



RFQ RF Joint Failure





Project X RFQ and 2.5 MeV Beamline



